

Advanced Fuel Cycle Initiative



Technical Monthly - April 2003

Technical Integration

- Attended Aqueous Separations Engineering Scale Demonstration Project 30% Design Review at INEEL and transmitted comments to Project Lead
- Participated in Burns & Roe and Westinghouse Savannah River Corporation 360-Degree Performance Review
- Developed and transmitted AFCI Narrative Comparison Matrices to DOE-HQ
- Developed ORIGEN2.2 Catawba/McGuire PWR MOX/LEU radionuclide inventories
- Attended National Technical Director Program Plan revision meeting in DOE-HQ
- Revised AFCI FY03 current and FY2004 through FY09 5-year budget summaries
- Met with Melissa and Sam to discuss work package process options for BCPs for FY03 and FY04.
- Prepared and reconciled FY03 AFCI work packages for integration and signature.
- Planned work scope and began writing/updating AFCI Five-Year Program Plan

For more information on Technical Integration contact John Kelly: (505) 844-8993

Systems Analysis

Transmutation Studies and Integrated Fuel Cycle Modeling

- [ANL, LANL] An overview of technical work on transmutation studies, dynamic modeling, repository benefit evaluations, proliferation resistance studies, and low conversion fast reactor safety studies was provided for the AFCI program quarterly report.
- [All] Revised work packages were created for Systems Analysis work; research scope and milestones were adjusted to reflect recent DOE budget guidance. Extensive work packages on Transmutation Studies and Integrated Modeling (including repository benefit evaluation and proliferation studies) were provided. The Low Conversion Ratio Fast Reactor Safety Assessment work package was moved from the Fuels area to the Systems area this month.
- [ANL] Numerous WIMS8 MOX/ UO_2 color set calculations with variations on the UO_2 pin enrichment and heterogeneous Pu or Pu+Np MOX pin content have been evaluated. An "optimized" peak pin power of 1.201 was observed for the case of MOX fabricated with separated Pu (6.4%Pu/HM average loading). In the case where Pu+Np are used in the MOX pin, the best-case peak power is 1.215 (8.3%Pu+Np/HM average loading). In both cases, the peak power occurs in the MOX assembly at the end of life (45 GWd/MT burnup). The use of Gd-poisoned pins in the UO_2 assemblies will be evaluated for further optimization of the peak power.
- [ANL] Previous evaluations of spent fuel characteristics of light water reactors have been

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based on assembly-level models. This month, an evaluation of a whole-core neutronic analysis tool (SOLTRAN code), which has options for detailed nuclide depletion and thermal-hydraulic (T/H) feedback, has been started.

- [ANL] WIMS8/ORIGEN2 analyses for two spent BWR fuel pins that will be processed in the UREX+ demonstration later this year were completed. A full report was written and issued.
- [LANL] For a simple proliferation metric, the required cross-section sets for a bare critical mass model have been assembled and tested. This buckling model reproduces more detailed calculations for many different Pu compositions and reasonable fractions of minor actinides.
- [LANL] Continued development of cost models for reprocessing and fuel fabrication.
- [LANL] Initiated collaboration with the University of California at Berkeley Nuclear Engineering Department to enhance the repository model in NFCSim.
- [LANL] Started effort to understand differences between NFCSim and COSI results for the benchmarking activity.
- [ANL] Reactivity coefficients were generated for compact and spoiled geometry low conversion ratio fast reactor configurations to test improved cross section data. Changes in most reactivity coefficients were observed to be insignificant. However, the sodium void worth changes by \$1 or more due to leakage effects in the voided above core reflector/plenum zone. The refined results yield better agreement with continuous energy Monte Carlo predictions; in addition, transport methods do not provide significant improvement, compared to diffusion theory results. Void worth errors are still observed for the highest leakage configurations.

- [ANL] An assessment of the applicability of WIMS8 for the analysis of the block-type VHTR assembly was initiated this month. The GT-MHR assembly design is being used in the study. It should be possible to account explicitly for the important double heterogeneity effect of the coated fuel particles in a graphite matrix, using the WPROCOL module of the WIMS8 code.

Repository Impacts

- [LLNL] DOE review of the Memorandum of Agreement between AFCI and DOE-RW continued. LLNL provided further workscope input to OCRWM contractor Booz-Allen-Hamilton.
- [LLNL] The impacts of alternative and/or advanced fuel cycles on geologic disposal were the subject of several discussions and papers presented at the “10th International High-Level Radioactive Waste Management Conference (IHLRWM)” in Las Vegas NV, April 1-3, 2003.
 - In the opening plenary on “National Programs” both Y. Le Bars (ANDRA - France) and S. Masuda (NUMO – Japan) included discussion of transmutation and advanced fuel cycle research in the context of future waste minimization potential, and the South Korea ‘Duplic’ research was discussed in the panel session in a similar context.
 - In a panel discussion on the “Role of Scientific Research and Technology Development for the Waste Management System” the potential benefits from advanced fuel cycles was discussed by several panelists and comments from the floor.
 - The paper “Canister-Array Configuration and Congruent Release of Long-Lived Radionuclides”, presented by D. Kawasaki and co-authored by J. Ahn, P. Chambre (all U.C.-Berkeley) and W. Halsey (LLNL) discussed

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potential design and performance impacts of alternative waste streams from transmutation.

- “Stress Corrosion Cracking of Martensitic Stainless Steels for Transmutation Applications” was presented by A. Roy, M. Hossain, B. O’Toole (UNLV).
- “A New Repository Waste Form: Graphite-Carbon High-Level Waste” by C. Forsberg, G. Del Cul, B. Spencer, E. Collins (ORNL).
- “Calibration of YXZ Sensors for the Measurement of Oxygen Concentration in Liquid Pb-Bi Eutectic” by X. Wu, N. Li, W. Hang, T. Darling (LANL), Y. Jiang, W. Yim, B. Fu (UNLV).
- “Thoria as a Waste Form”, J. Tulenko, L. Argo, R. Baney, P. Demkowicz, N. Shibuya (Univ of Florida)
- Other papers not directly focused on AFCI addressed topics such as ‘Dry Nuclear isotopic Dilution’, ‘Repository Criticality’, ‘Thermal Limits’ and ‘Waste Stream Inventories’ that are of technical interest to AFCI.

The AFCI program in the U.S., and other programs internationally, have the potential to produce significant results between now and the next IHLRWM meeting in the fall of 2005. Bill Halsey recommended to the technical organizing committee that one or more ‘Advanced Fuel Cycle’ oriented sessions would be appropriate for that meeting, and such a session is now included in preliminary planning for IHLRWM-11.

Other

- [LLNL] LLNL staff contributed to program performance evaluations.
- [ORNL] Assessed impact of receiving five-fold reduction in funding for FY03

- [ORNL] Discussed downsized work scope with ANL and BNL

For more information on Systems Analysis contact Ralph Bennett: (208) 526-7708

Separations

Advanced Aqueous Separations

- **[ANL] AMUSE 2.3 Development.** Code was added to generate a new worksheet named “Run Status” to the Results worksheet. This sheet contains information about the run including number of iterations it took to converge, the version of AMUSE that was used to generate the reports, and the time it took to run. AMUSE 2.2 has gone through in-house testing that resulted in some corrections. Version 2.3, which contains the improved report generator and other minor improvements, will be released in mid-May.
- **[ANL] UREX+ Laboratory-Scale Hot Demonstration.** Spent fuel from the Big Rock Point Reactor (Michigan) will be dissolved in HNO_3 to provide the feed for the UREX+ process demonstration. ORIGEN2 dose calculations were used to determine the type of facility needed for each separation process. Recovery of U and Tc will be done in the shielded cell, the Tc stripping in the glovebox, and U stripping in a hood. The entire Cs/Sr process will be done in the shielded cell. For Pu/Np separation if a TBP-only-based process is selected, the extraction will be done in the shielded cell, and the Pu/Np stripping may be performed in the glovebox. TRUEX recovery of Am/Cm/RE would all be performed in the shielded cell. If TRUEX is selected to recover both Pu/Np and Am/Cm/RE, extraction and Am/Cm/RE stripping will be done in the shielded cell; Pu/Np stripping could be performed in the glove box. For the Am/Cm separation from the RE, the extraction will be done in the shielded cell and the Am/Cm stripping could be performed in the glovebox.
- **[ANL] Fuel Dissolution Tests.** Scoping tests for the dissolution of irradiated fuel were carried out. Three dissolution experiments were conducted in which about 130 g UO_2 sintered pellets were dissolved in about 250 mL of nitric acid at 125, 150, and 175°C. The goal was to generate a solution that contained 450 g U/L and a total acidity of 0.8 M. After 2 hours of heating at temperature, residual UO_2 was found at 125 and 150°C.
- **[ANL] Laboratory-Scale Hot Demonstration - Pu/Np separation.** The extraction process for the separation of Pu/Np from minor actinides and remaining fission products follows the Cs/Sr extraction process (CDC-PEG process). Plutonium and neptunium extract into TBP-based systems in either the (IV) or (VI) oxidation state but are present as Pu(III) and Np(V) when they exit in the raffinate of the CDC-PEG process. Reducing and oxidizing alternatives for Pu and Np are being considered. Because the raffinate from the Cs/Sr extraction process contains significant amounts of reducing agent and organic compounds (AHA and its hydrolysis products and minor concentrations of the CDC/PEG-solvent components), it might be more convenient to keep Pu and Np in the (IV) oxidation state instead of oxidizing them to the (VI) state. Optimizations of the redox conditions experiments were conducted. Both Pu and Np were extracted from 5.5 M HNO_3 with constant D values over four consecutive contacts. More than 99.9% actinides were removed after the four contacts. The scrub and strip processes are being investigated.
- **[ANL] Contactor Fabrication.** Work continues on the construction of the 24-stage 2-cm centrifugal contactor for the shielded-cell facility. The 24 stages will be complete by May 31, with individual banks of four contactors delivered as they are completed. Quality verification and hydraulic performance testing will proceed on each bank as they become available.
- **[ANL] Analysis of SRTC UREX Demonstration with Dresden Reactor Fuel.** A letter report was issued that summarizes a series of AMUSE flowsheet simulations of the SRTC UREX demonstration with spent nuclear fuel. AMUSE

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was used to evaluate the process under the conditions reported by the SRTC in order to determine the contribution of variations in operating conditions to the observed product compositions.

- **[ORNL] UREX+ Laboratory-Scale Hot Demonstration.** Plans for the UREX+ Solvent Extraction Hot Tests conditions have been chosen and were discussed in the Separations Working Group Meeting on May 13-14, 2003. The first test is scheduled for June 2003. Test conditions for the second test, scheduled for July, will be finalized after analysis of results from the first run have been completed.
- **[ORNL] Americium-Curium Separation from Lanthanides.** The experimental plan for testing the BTP extractant, 2,6-bis(5,6-di-ethyl-1,2,4-triazin-3-yl-pyridine, is being developed. The use of a modifier such as n-octanol in the diluent will be evaluated and a concentration determined.
- **[INEEL] Engineering-Scale Demonstration Facility Feasibility Study.** All feasibility study work with Washington Group International (WGI) is proceeding on schedule and cost. The principal effort to date includes: (1) development of separations and solidification process flows; (2) development of process equipment sizing and equipment list; (3) development of operations/throughput basis/approach; (4) development of equipment and facility arrangement layout; (5) evaluation of fuel characterization and development of source terms; (6) fuel preparation study; and (7) addressing criticality control requirements. An over-the shoulder review was held in Denver on April 2 in which the current status was presented to J. Laidler (National Technical Director of the AFCI Separations Program) and John Herczeg (DOE-HQ). A 30% design review was held April 23-24 at the INEEL.
- **[INEEL] Cs/Sr Extraction Process Development.** Laboratory testing continued for development of a chlorinated cobalt dicarbollide (CDC)/polyethylene glycol (PEG) based solvent extraction process for the separation of Cs and Sr from dissolved LWR fuel. Acid dependency data were obtained for Cs and Sr at temperatures of 15°C, 25°C and 35°C using a solvent composition of 0.08 M CDC, 0.6 vol% PEG in a phenyltrifluoromethyl sulfone diluent. The effect of AHA in the UREX raffinate on the CDC/PEG process was also evaluated. The presence of AHA, which has not decomposed, has very little effect on the distribution coefficients for Cs and Sr. Once AHA has decomposed to form hydroxylamine, the extraction distribution coefficient for Sr is reduced significantly (from 2300 to 250 at an O/A=1.0), but remains sufficiently high. It has been determined that the CDC/PEG solvent has a slight affinity for the actinides at low acidities. The use of a nitric acid scrub is effective in minimizing the amount of actinides extracted. Testing will continue to optimize the composition of the scrub solution and to develop a method to decompose the hydroxylamine in the feed to the CDC/PEG process.
- **[WSRC-SRTC] UREX demo cleanup.** The centrifugal contactors used for the UREX demonstration were removed from the Shielded Cells Facility, and were discarded as waste. Any future solvent extraction work in support of the AFCI will be limited to the use of a mini-mixer/settler in a hood or glovebox.

Pyrochemical Separations

- **[ANL] PYROX Process Development.** A second high-capacity reduction cell experiment was initiated to assess limiting conditions at the anode of the cell (i.e., anode blocking effect), evaluate methods of oxygen gas removal from the cell to increase current efficiency and prevent corrosion, and develop oxygen gas monitoring capabilities to follow the extent of reduction.

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- **[ANL] Anode Materials Development.** Polarization cell testing and thermal analysis were used to evaluate the stability of SrRuO_3 -composite anode materials. Although the composite material performed well in the polarization cell, analysis of the material revealed that the SrRuO_3 reacted with the binder resulting in the formation of RuO_2 . Alternative binder systems for SrRuO_3 -based anodes will be evaluated as well as composite anodes fabricated with RuO_2 .
- **[ANL] Advanced Electrorefiner Development.** The concept layouts for the Planar Electrode Electrorefiner (PEER) prototype module were completed. Detailed design was initiated of the cover and heat shield assembly, which will be installed on the Mk-III electrorefiner well in Illinois and interfaced with the PEER module itself. It is planned to complete this part of the design and submit it for review and fabrication while the detailed design of the module is completed. The first review should be accomplished in late May or early June. In support of the PEER design, a test series using the high-throughput anode and MK V cathode design was initiated to determine the effectiveness of intermittent U removal from the cathode by scraping as a function of the amount of U electrodeposited on the surface and deposition conditions (e.g., current density).
- **[ANL] Advanced Electrolysis System Development.** Fabrication of the cell components for the advanced U/TRU electrolysis system is nearing completion. Cell control hardware and software are being assembled and tested prior to installation in laboratory. Safety review documentation is being reviewed by ES&H personnel.
- **[ANL] TRU Recovery with the Liquid Cadmium Cathode.** Fabrication activities were initiated on the additional items of support equipment needed for Liquid Cadmium Cathode (LCC)

handling. Design activities continued on equipment to allow recycle of the transuranic product from the LCC. A qualification test procedure for operation and maintenance of the LCC was reviewed by technical, operations, quality assurance, and safety personnel and comments are being incorporated. An analysis of the LCC mock-up test equipment was completed to determine its resistance to accidental tip over and it was found to be stable under all expected operational conditions. An analysis was also completed to determine if alpha sensitive constant air monitors (CAMs) were needed in the Fuel Conditioning Facility (FCF) because of the planned LCC testing. The analysis concluded the existing beta-gamma sensitive CAMs would be more effective at detecting off-normal conditions than alpha CAMs based on the mix of radionuclides in the Mk-V electrorefiner salt and LCC product.

Engineered Product Storage

- **[ANL] Means for recovery of Technetium and Its Conversion to Metal.** A letter report was issued that evaluates processing options for technetium recovery and conversion to metal. The report includes a review of published processes that have been used to separate technetium in nitric acid media, further purify it, and reduce Tc to metal. Six potential process flowsheets that convert technetium from a UREX product stream to purified metal are discussed.

Spent Fuel Treatment Facility Design

- **[INEEL] Spent Fuel Treatment Facility (SFTF) Design Support.** Work to date on this task has primarily focused on the development of High-Level Functions and Requirements (F&R's) for the facility. A draft of the F&R's for the SFTF were reviewed by the Separations Working Group members on the Functional and Operations Requirements Development Team in February at the INEEL. Comments from this working

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group were incorporated and a second draft delivered to the group for review. Some discussion was held with J. Herczeg and J. Bresee on a peer review of the F&R's to support CD-0. It was tentatively decided that this review should occur concurrent with preconceptual design and prior to obtaining CD-0 so information gleaned from preconceptual design could be included in the F&Rs to support the CD-0 process. A draft Statement of Work (SOW) for the Architect-Engineering (A-E) firm was also completed and includes studies for the A-E to look at both aqueous processing and pyrochemical processing alternatives. This SOW was also given to the Separations Working Group for review. The current contract with WGI allows for the SFTF preconceptual design to be added as a second phase of work. Due to the delay in obtaining NE funding, the preconceptual design work on the SFTF will not begin until late summer.

- **[WSRC] *Deployment Strategy*.** A first cut of the deployment plan outline and initial strategy text was issued for review by the Deployment Activity team members. In addition, the SFTF deployment planning matrix (initiated at a prior Activity Team meeting) was updated and will be used extensively in determining alternatives and action items to refine the deployment strategy.
- **[WSRC] *Transportation*.** A document entitled AFCI Transportation Requirements (DRAFT) was issued for review and comment. The document depicts the various transportation streams with associated purpose and interfaces. The document is a first cut at looking at transportation issues that would impact deployment strategy. Feedback will be used to further develop those areas that may be important to cost benefit resulting from deployment options.
- **[ORNL] *Deployment Plan*.** Input was provided for the Deployment Plan as part of the multi-site

support for that effort. SRS has provided a draft of the Deployment Plan for further review and input. Contributions have centered on capital costs as a function of plant throughput, spent nuclear fuel feed strategy, and nuclear growth scenarios. Draft white papers on each of these three subjects are completed and work continues on finalizing the reports. Efforts supporting the Deployment Plan are continuing.

- **[ORNL] *Voloxidation Process Development*.** As part of a collaborative effort with ANL-W, a draft version of the proposed outline for the development of an advanced "Voloxidation Process" for the dry, head-end removal of volatile fission and activation products has been prepared.

Advanced Process Development

- **[LANL] *Actinide Crystallization Process - Bench-Scale Crystallization Tests*.** Simulant solutions of LWR spent fuel dissolved in nitric acid were prepared containing uranium and a subset of nonradioactive fission product elements. The hot solution was divided into three vials that were cooled to different temperatures: room temperature, 5 C and -4 C. Crystallization usually occurred between 15 minutes and 2 hours and was usually faster at -4 C. The crystals took the shape of small yellow needles. The crystals were washed in cold nitric acid of the same molarity used for dissolution. The decontamination factors are generally in the range of those reported by a Japanese group using a similar procedure with a crystallization temperature of 10 C.
- **[LANL] *Actinide Crystallization Process - Loop crystallizer tests*.** A loop crystallizer is being fabricated to test the uranium nitrate crystallization process. This system will provide the smallest unit for testing the process in a continuous mode. Several simplifications have been incorporated in the process arrangement.

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The result of this is a reduction of equipment and instrument items, and less complex process control.

EBR-II Spent Fuel Treatment

- **[ANL] Report to Congress.** A report is being prepared by DOE to address the treatment of EBR-II driver and blanket fuels. The report was requested by Congress. To support this effort, costs and schedules for twelve treatment options were developed by ANL. Discussions were also held with DOE-NE personnel to clarify questions with various cost elements.
- **[ANL] Spent Fuel Processing.** Forty-eight kilograms of heavy metal from blanket material were processed in the Mark-V electrorefiner during the month of April. Processing the blanket fuels serves to increase the plutonium content in the salt in support of transuranic recovery tests. A total of 238 kilograms of fuel has been treated in FY03.
- **[ANL] Cladding Hull Storage.** Fabrication of the adapters and containers to allow cladding hull storage in the Hot Fuel Examination Facility (HFEF) was completed. A qualification test procedure for this equipment was also reviewed and approved. Cladding hull storage is needed in HFEF to free space in FCF and to support production of the metal waste that will occur in HFEF.
- **[ANL] Metal Waste Form Process Development.** The first of five new vacuum pumps from Vacuum Research Corporation was delivered for use in the Metal Waste Form Furnace. The unit successfully completed acceptance testing and was subsequently modified to improve remote handling and enable easier in-cell parts replacement. The next two pumps, intended for installation in the Cathode Processor, are scheduled to be delivered in early May. Final assembly and shipment of the last two pumps, one intended for the Casting Furnace and one spare, are awaiting receipt of additional pump parts from the vendor's subcontractors. (ANL)
- **[ANL] Metal Waste Form Testing.** Tests to measure the dissolution rate of the metal waste form in various pH solutions at several temperatures have been completed. These rates will be used to show that the HLW glass degradation model to be used in Yucca Mountain performance assessment calculations will bound radionuclide release from the metal waste. A report is being prepared to document the results and support this approach. New leachate samples from long-term leach tests of metal waste form material were analyzed by inductively coupled plasma – mass spectroscopy (ICP-MS). These analyses were performed using the newly developed technique that allows all analytes to be measured by ICP-MS. This technique significantly reduces both the time required for the analysis and the waste generated. Scanning electron microscopy to characterize corrosion products on metal waste form coupons leached in chloride solutions continued. Results of the most recent analyses were reported in an intra-laboratory memo. Results from this work will be used to improve models used to predict long-term metal waste form behavior.
- **[ANL] Ceramic Waste Form Process Development.** A solicitation for bids is ongoing for the procurement of a prototype production scale ceramic waste furnace. Five vendors were initially contacted and three have shown interest in bidding. Questions from the vendors are currently being answered and therefore the bid process will remain open until all questions are addressed and vendors are able to supply ANL with a bid.
- **[ANL] Modern Process Equipment Inc.** is

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currently grinding approximately 200 kg of zeolite pellets to support ceramic waste experiments. The zeolite will be done by the middle of May. (ANL)

- **[ANL] *Ceramic Waste Form Testing.*** Characterization of samples of ceramic waste form material obtained using an experimental sampling method continued. Samples were prepared for and examined by scanning electron microscopy. No significant differences were observed between bulk material and material obtained by the new sampling method. This sampling technique may be used during the large-scale processing of ceramic waste. Elemental analysis of ceramic waste form material containing ^{238}Pu continued. This material is being used to evaluate radiation damage effects in the ceramic waste form. Compositional data will be used to help interpret results from leach tests performed on this material. Six of the nine ceramic waste form materials with various salt loadings and glass-to-zeolite ratios have been made and samples are being prepared to determine these compositional effects on the phase distribution (by XRD), chemical durability (by Product Consistency Tests), and hygroscopic behavior (by vapor hydration tests). Samples of ceramic waste form materials held at 400 or 500°C for between one week and one year are being examined and tested to determine the effect of heating on the phase stability, chemical durability, and microstructure.

***For more information on Separations contact
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Integration

- [NTD] After discovering that most of the non-fertile nitride fuel pellets prepared for AFCI-1 (a) irradiation, a meeting was held in Idaho Falls on April 1 among the LANL, ANL and INEEL staff to decide on the path forward. Even though, the most likely cause of damage is thought to be the fabrication process that resulted in more than normal fragility in the pellets, a review of the entire process from fabrication to reactor insertion was performed and an action plan was developed. Following the action plan, the non-fertile pellets will be prepared in parallel to fertile-free pellets for October'03 insertion.
- [NTD] Fuel development work-packages were revised based on the new DOE budget guidance and submitted to SNL. During this process, the WBS also was revised for the fuel development.
- [NTD] The fuel development NTD attended a meeting held by the proposed University Consortium for Transmutation Research in Las Vegas Nevada on April 29, 2003. The NTD gave a presentation on the role of ADS in U.S. nuclear future and participated in the group discussion sessions.
- [NTD] Based on a meeting held in Washington D.C. among the AFCI NTDs, the AFCI program plan is being revised and the revisions on the fuel development section has been started.

Series One Fuels Design, Specifications and Analyses

- [WSRC] We continued development of the Series 1 MOX Deployment plan, including reviews of MOX Fuel Fabrication Facility (MFFF) design documentation (weapons MOX) for background.
- [WSRC] The FDWG member worked with the Separations Working Group to issue the AFCI Transportation Requirements (DRAFT) for review and comment. The document depicts the

various transportation streams with associated purpose and interfaces. (Interface with Separations)

- [WSRC] We are incorporating comments from an internal review of the draft white paper "Evaluation of Initial Market for MOX from Recycled Commercial Spent Nuclear Fuel".

Series One Fuel Development & Fabrication

- [LANL] We completed the calculations of the equilibrium of phases in the C-O system by relating the thermochemical data for partial pressure of oxygen to the Gibbs free energy of phases. After testing and validating the results, we will use the same method for the U-O and Pu-O systems.
- [LANL] The second double workstation glovebox at MST is now fully operational and able to maintain levels of oxygen > 1 ppm and moisture > 5 ppm in support of Series One fuels.

Series One ATR Irradiation Experiments

- Because of uncertainties in INEEL budget, no activities were initiated in March. This work will begin in April.

Series Two Fuel Design Specification and Analyses

- No reportable progress in April

Series Two Nitride Fuel Development

- [LANL] Non-fertile nitride pellets were fabricated using alternative route, which produced 100% of pellets within the physical inspection specification (i.e., dimension and density). The improved processing also eliminated any apparent endcapping.
- [LANL] Methods for testing for endcapping of pellets have been investigated; they include a loading proof test and a submersion in alcohol. To date, no internal cracking has been detected.
- [LANL] Radiography has been performed on a number of test pellets. No cracks have been

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observed by this method, however, the resolution of the digital acquisition system—not as high as film—may not be adequate to detect very fine cracks. The radiographers are investigating the use of film in addition to the digital acquisition system.

- **[LANL]** Highly enriched uranium oxide has been acquired, and the U_3O_8 feedstock has been reduced to UO_2 .
- **[LANL]** Processing has begun at MST with ZrN-UN in the effort to better understand the solid solution behavior of ZrN-ActN (actinide nitrides) during sintering.
- **[LANL]** The metals Si, Sc, Mn, and Co were evaluated this month as potential sintering aids for ZrN. The results showed density increases of several percentage points relative to processing of pure ZrN.
- **[LANL]** TEM observations have shown an implantation rate dependence of microstructural defects (at a given dpa) for Xe implantation into ZrN.
- **[LANL]** The complete fitting database for the modified embedded atom model for AmN was constructed from first principles calculations, as there is basically no experimental data in the literature. The database includes AmN in the B1 crystal structure, its elastic constants, as well as the energies of formation, i.e., the relative energies to pure americium and nitrogen in reference structures. All calculations were performed using the same method as for the pure americium case, i.e., a self-consistent full potential linear muffin-tin orbital method based on the local spin density approximation.
- **[IC, LANL]** Quantum mechanics calculations that predict structures and energies of UN-TiN solid solutions are being conducted as a means to

evaluate the reliability of the UN-ZrN simulations (modeling of the UN-ZrN system also continues). The initial results for the series of UN/TiN compositions (stoichiometries) suggest that this system does follow a simple rule of mixtures (i.e. take values which are an average between the components), in contrast to results for UN-ZrN

- **[ASU, LANL]** Fracture toughness and Vickers hardness tests have been carried out in ZrN samples with and without post-sinter heat treatment, and an improvement in mechanical properties has been observed with heat treatment. Scanning Electron Microscopy has been carried out on the fracture surfaces of broken samples with and without heat treatment, and evidence points to strengthening of the matrix-particle interfaces as a reason for the increase in mechanical properties after the heat treatment.

Series Two Metallic Fuel Development

- **[ANL]** A series of nuclear materials transfers were made to allow the Casting Laboratory to support preparation for and fabrication of AFC-1F low-fertile fuel specimens. Feedstock was selected and staged. Decontamination of the Casting Laboratory Glovebox is underway.

Series Two Advanced Fuel Forms

- **[LANL]** RuAl and “Fissium” ($Mo_{0.5}Ru_{0.2}Pd_{0.15}Rh_{0.15}$) buttons were synthesized by arc melting. TEM foils of these and other related materials will be prepared for insertion in the STIP-IV irradiation.

Series Two ATR Irradiation

- **[ANL]** The document titled Fuel Test Specimen Specification for the AFC-1F Low-fertile Fuel Capsule Irradiation in the ATR (W720-0527-ES-00) was submitted in completion of the milestone titled “metallic fuel draft input for low-fertile transmuter fuel specification.”
- **[ANL]** The as-built experiment data package for the AFC-1B and AFC-1D rodlets was finalized

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and approved prior to loading the rodlets into the test capsules.

- **[ANL]** Capsule fabrication was completed for the AFC-1B and -1D non-fertile metallic fuel tests. Capsules were loaded, closure welded, leak tested, and visually and dimensionally inspected. Capsules were radiographed for capsule closure weld conformance to specification and fuel configuration within the capsule. Welds were subject to die penetrant inspection. The capsules have been loaded into the shipping container for storage to await shipment to the Advanced Test Reactor, which is tentatively scheduled for May 28.
- **[ANL]** Radiography of nitride fuel pellets encapsulated into rodlet specimens was completed. Due to the high gamma field from the rodlets with high americium content, several radiography trials were necessary before an acceptable exposure was obtained. A report is being assembled.
- **[ANL]** The nitride fuel compositions were established for Experiment AFC-1Æ, which is scheduled for an October insertion in ATR. Experiment AFC-1Æ being a consolidation of Experiments AFC-1A and AFC-1E, will consist of non-fertile and low-fertile actinide-bearing nitride compositions.
- **[ANL, INEEL]** Based on the LHGR reported in the physics analyses of the metallic fuel, the preliminary enrichment values of the metallic fuel reported in the DRAFT Experiment Description of AFC-1E and AFC-1F will remain the same except for Rodlet 2. For the nitride fuel compositions, the initial calculations indicated a peak LHGR of 26.3 kW/m. The enrichment values for the nitride fuel compositions were increased from 40 wt% to 45 wt% U-235 to achieve a LHGR closer to the nominal design value of 300 kW/m.
- **[ANL]** The constituent fuel mass of the AFC-1Æ and AFC-1F experiments were determined based on the new nitride compositions and revised enrichment values. These data were supplied to INEEL to calculate the LHGR and burnup of the experiments. The results will be completed and disseminated during the first part of May.
- **[ANL]** Preparations were made in anticipation of the upcoming ATR cadmium basket fabrication. Machining fixtures were fabricated and tested.
- **[INEEL]** We reviewed, approved and issued the Technical and Functional Requirements (T&FR) document for the ATR baskets. Also, the AFC-1 formal basket design verification was held and the AFC-1 basket drawing was approved and issued. Basket fabrication is scheduled to begin the first week in May.
- **[ISSUE]** The contract from INEEL to ANL-W for fabrication of cadmium baskets for the AFC-1A - 1D experiment insertion in ATR had not been received at ANL by the end of April. A three weeks lead time is required between letting this contract and basket delivery to ATR.
- **[ANL]** We will fabricate one additional dummy capsule to take the place of the AFC-1A and AFC-1C nitride pellet tests that will not be inserted in May.
- **[INEEL]** The ATR canal storage grid for the AFC-1 experiments has been fabricated and will be placed in the canal prior to 131A outage.
- **[INEEL]** Neutronics analysis has been completed for AFC-1(A-D). An Engineering Design File (EDF) was issued and is currently being reviewed. The EDF is scheduled to be issued the first part of May. The thermal analysis is being performed and scheduled for completion the first week in May. Also, the stress analysis to support the Experiment Safety Assurance Package (ESAP) has been reviewed and approved. An EDF was issued in late April.

Fuels continued

- **[INEEL]** We analyzed the cadmium corrosion in the ATR and ATR canal. An EDF was issued for review.
- **[INEEL]** The ESAP is currently being revised to reflect the removal of AFC-1A and 1C data. Physics and stress evaluations are also being incorporated. TRA review is scheduled for early May.
- **[INEEL]** The ATRC facility mockup test has been completed. Reactivity measurements came well within the calculated measurements. Comparisons will be documented and used as a benchmark.
- **[INEEL]** All transportation documentation and work orders have been issued for a May 28 receipt of the experiment assemblies AFC-1B and 1D.
- **[INEEL]** A Draft AFC-1 A-D Test Plan was prepared and submitted to the Fuel Development NTD in accordance with the March 31, 2003 AFCI Project milestone.

Series Two FUTURIX Irradiation

- **[ANL, LANL]** A meeting of fuels staff members from ANL, LANL and DOE was held with CEA in Cadarache on April 29-30. Progress was made toward final design of the FUTURIX fuels irradiation experiment. A delay in Phénix insertion of the experiment from April to November of 2006 was announced by CEA due to the delay in U.S. delivery of the americium needed for fabrication of the European fuels, but irradiation in two full power cycles is still possible at this time.
- **[ANL, LANL]** Discussions held with CEA with respect to the methodology in place in the U.S. labs to assure quality indicate that they are adequate and acceptable to CEA.

- **[ISSUE]** Failure to ship CEA a supply of americium by September of this year could jeopardize the FUTURIX irradiation schedule.

Looking Ahead

- Third FDWG meeting will be held in Idaho Falls on May 21st and 22nd, 2003. Any inquiries about this upcoming meeting should be addressed to Kemal Pasamehmetoglu at kop@lanl.gov.
- The fertile-free metallic fuel samples will be inserted into ATR for AFC-1 (b) tests during the last week in May. Inquiries about the AFC-1 (b) insertion schedule should be addressed to Richard Ambrosek at rca@inel.gov.
- A technical workshop on “Materials Modeling and Simulation for Nuclear Fuels,” will be held in Santa Fe, New Mexico on June 9-10, 2003. For additional information on the workshop please contact Marius Stan (mstan@lanl.gov).

For more information on Fuels contact Kemal Pasamehmetoglu: (505)667-8893

Transmutation

INTEGRATION [LANL]

- [LANL] A new revision of the Transmutation Engineering portion of the AFCI Program Plan was developed with input from the work package managers and integrated into a single plan containing milestones, performance measures, and schedule, and including new cost estimates for all activities. Some success was made in integration of activities with the Generation IV program in the area of structural materials data and heavy-metal coolant technology.
- [LANL] Meetings were held with DOE program managers, Laboratory partners, and University participants, to complete final revisions on the FY03 work packages. Final work packages were submitted to the AFCI integrator.
- [LANL] The National Technical Directors for Transmutation Engineering and for Fuels Development participated in an international meeting on the development of ADS for transmutation held at the UNLV. A University Consortium for Transmutation Research will be proposed to address many of the important issues related to ADS that were discontinued by the AFCI program. The European participants described a very ambitious program for ADS Research and Development that puts them in the forefront for this technology.

PHYSICS

Cross-Sections

- [ANL] A preliminary analysis of the TRAPU experiment with JEF2.2, ENDF/B.V and ENDF/B.VI nuclear data has been carried out. Results appear to be consistent with the previous PROFIL experiment analyses.
- [LANL] Helium production results for Ni-58 and Ni-60 were completed for neutron energies from threshold to 100 MeV. The results generally agree with LANL evaluations up to 50 MeV, but are not in agreement from 50–100 MeV.

Spectro-data are being produced to investigate aspects of the nuclear reaction models. Further data analysis of hydrogen and helium production data taken in the last beam cycle is in progress.

- [LANL] The first samples of chromium foils were obtained in LANL's MST Division by means of electroplating.

Codes (Fuel Cycle Method Code Development)

- [LANL] We have made progress on evaluating the Am-241 (n,2n) cross section with the GNASH code, a nuclide identified as being of concern for the AFC program because of significant uncertainties on its capture, inelastic, fission and (n,2n) cross sections. Our calculations can reproduce the shape of the (n,2n) near 14 MeV, where measurements exist from Livermore and from Russia. Also, we have collected data for the capture branching to Am-242 ground and metastable states, since this is not currently in the ENDF evaluation. This evaluation will be based on both experimental data and GNASH model predictions.
- [LANL] We presented results on integral data testing of our actinide data using fast and thermal critical assemblies, as well as our capabilities in evaluating and processing uncertainty (covariance) information at the Gen-IV nuclear-data-needs workshop held at BNL.
- [ANL] For the fuel cycle method code development, the first-order spherical-harmonics approach was refined to reduce the computational

Transmutation continued

burden and make use of more general interface conditions for low-density-region treatment in the variational nodal transport method.

MALIBU

- **[ORNL]** Availability of data to the AFCI Program from the MALIBU program for use in validating LANL codes such as MONTEBURNS is under discussion, as Belgonucleaire requires an additional payment (~\$160K) to add data availability for more than one institution (other than ORNL). Validation of the MONTEBURNS code using MALIBU Program data may need to be performed at ORNL.

STRUCTURAL MATERIALS

Materials Testing

- **[LANL]** Specimens were received and prepared for STIP IV irradiation at PSI. Materials include T-91, HT-9, ODS strengthened ferritic/martensitic (F/M) steels, high purity tantalum, and ceramic fuel matrices. Materials will be irradiated at a maximum temperature of 450°C and to a maximum dose of ~15 dpa.

Hot-Cell Activities

- **[LANL]** Modifications were made on the three-point-bend test fixture to improve high temperature testing results.
- **[PNNL]** The F/M inventory recovery plan is under discussion, focusing on which specimen types to inventory first.
- **[PNNL]** We submitted an abstract to the 11th International Conference on Fusion Reactor Materials describing AFCI-related research results on compression-test behavior of irradiated materials that exhibit localized deformation—similar to that observed in LANSCE-irradiated AFCI materials.

Materials Handbook

- **[LANL]** A second draft of the Materials Hand-

book chapter on tantalum underwent formal reviews; final revisions were made, and the chapter is undergoing final formatting.

- **[LANL]** Work continued on Materials Handbook chapter covering HT-9 [12% Cr] steel. Sections on fatigue, creep behavior, and fracture toughness are being prepared. Information on several Russian steels similar to HT-9 is also being assembled for inclusion in the HT-9 chapter.

Radiation Damage Modeling

- Nothing to report

COOLANT TECHNOLOGY

DELTA loop

- **[LANL]** We have been injecting a hydrogen/helium mixture into the DELTA Loop to clean up excess oxygen/oxides in the liquid LBE. Due to extensive test operations without coolant cleaning, the loop accumulated a considerable amount of oxides, and the melt tank had to be opened to manually scoop the oxides from the LBE melt pool. Subsequently, the oxygen sensors showed improvement, and the many hours of cleaning operation further demonstrated the stability of the loop and the instrumentation, and validated our understanding of the coolant chemistry and responses.

LBE Technology and Corrosion

- **[LANL]** The oxygen sensor calibration stand was moved into a new laboratory and a new HCP was prepared. Software for a new data-acquisition and temperature-control system was written. The stand will be used to test the FZK oxygen control system.
- **[LANL]** TRAC assistance was provided to MEGAPIE for running a constrained steady-state calculation and on modeling a valve that can be controlled on a temperature difference.

Transmutation continued

- [LANL] Two papers, “Modeling Corrosion in Oxygen Controlled LBE Systems” and “Oxygen Sensor Calibration For LBE Coolant Chemistry Control” were presented at the ICONE11 conference, held in Tokyo, Japan. An AFCI staff member toured JNC Orai Engineering Center and JAERI Tokai Center (LBE test loop and facilities, HTTR and JOYO).
- [LANL] The LBE technology development work packages were re-partitioned to move certain tasks to the Gen IV LFR (SSTAR) program.

ACCELERATOR-DRIVEN SYSTEMS

MUSE

- [ANL] Investigation of reflector effects for configurations similar to the MUSE experimental setting continued, applying the macrocell approach to a more realistic model in RZ geometry. The results obtained are satisfactory since the 33-group calculations give sufficiently accurate results for both the reactivity value and fission rate (or flux) distributions when compared to the reference results.
- [ANL] The MUSE Technical Program Committee met in April at Cadarache to determine the objectives for the remainder of 2003. Measurements continued in the SC2 configuration (-3000 pcm nominal). Pulsed Neutron Source measurements were taken at different levels of subcriticality (achieved by control rod movement), and other measurements included foil irradiations and Cf source traverses.

MEGAPIE

- [LANL] Review of target drawings and documentation continued as the major focus of activity. One of eight Lots was released for manufacture.
- [LANL] Fill and Drain System design and manufacture activity was restarted this month.

- [LANL] DOE contributions to the MEGAPIE Project included the completion of a TRAC model of the MEGAPIE system, and the continued work on reliability with a focus on the requirements for the Readiness-for-Manufacturing objectives.

TRADE

- [ANL] Detailed discussions at a TRADE progress meeting in Rome subsequent to a TRADE team visit to the ISIS facility in England, led to the decision to make the tantalum target the reference for TRADE.
- [ANL] The miniature (1.5 mm) fission chambers to be used for spectral-indices measurements in the TRADE experiment were tested in the EOLE and MINERVE reactors, and are ready to be shipped to Casaccia for a June experiment.
- [ANL] Four critical experimental configurations measured last November at the TRIGA reactor in Rome were calculated using the MCNP code. A systematic discrepancy on the order of +3000 pcm has been observed, and discussions with our Italian and French colleagues are underway to explain this discrepancy.
- [LANL] A final matrix was created at LANL, comparing the properties of tantalum, tungsten and clad tungsten as possible target materials.

UNIVERSITY PROGRAMS

University of Michigan

- [LANL] T-91 and HT-9 samples have been implanted with 100-appm He in preparation for an irradiation at 450°C to 3, 7, and 10 dpa using 3.0-MeV protons.
- [LANL] A number of REBUS calculations have been performed for low conversion-ratio fast-spectrum transmuter configurations, where the use of burnable absorbers or denatured thorium cycles is being considered.

Transmutation continued

North Carolina State University (NCSU)

- [LANL] Comparative analysis of radiation damage at SINQ Targets 3 and 5 and at SNS continued. We have found that displacement production at the centers of the aluminum entrance windows at all three spallation-neutron-source facilities was due chiefly to protons, not spallation neutrons. On a per-unit-proton-beam-current basis, the displacement production rate at SNS was about half of the rate at SINQ Targets 3 and 5. This is attributed mostly to a larger and less focused proton beam at SNS.

University of Texas-Austin

- [LANL] Visual coding using Visual Basic and the MS Visio software to create a user-friendly application for evaluating fuel cycles for proliferation-resistance assessments continued.
- [LANL] The proliferation-resistance assessment methodology was presented to the Blue Ribbon Committee on Nuclear Nonproliferation. Committee members subsequently requested execution of various cases for their further study. Results will be produced in May and forwarded to the committee.
- [LANL] Cross-section uncertainty sensitivities in transmutation systems are being evaluated using a full-core ADS simulation with MCNPX linked to ORIGEN and NJOY99 for cross-section processing.

University of Illinois at Urbana Champaign

- [LANL] The assembly of the LBE test apparatus continued with the construction of the cooling systems and the development of the gas delivery system.
- [LANL] A final report on construction, testing, and demonstration of the LBE loop (Phase I) was completed, and experiments (Phase II) have commenced.

University of Florida

- [LANL] Servicing and calibration of the thermogravimetric analysis (TGA) equipment was completed.
- [LANL] Preliminary baseline thermogravimetric analysis and oxidation studies of SS-316L is in progress.
- [LANL] Bulk machining of one lot of HT-9 samples was completed, and final machining is in process.

LANL University Programs Leader

- [LANL] As Technical Program Chair, the AFCI University Programs Leader (UPL) continued coordination of the program for the ANS annual meeting with the embedded AccApp'03 Topical, which includes over 170 papers and strong participation from AFCI university programs.
- [LANL] The AFCI UPL coordinated the UT-Austin presentation of Proliferation Modeling for the DOE Blue Ribbon Panel on proliferation-resistant nuclear power.
- [LANL] AFCI colloquia and discussions of potential research topics to recruit students for the AFCI university program were held at the University of Missouri (Rolla and Columbia).

[LANL] A technical and programmatic review was conducted of the University of Illinois' Phase II proposal to begin experimental investigation of the feasibility of *in-situ* measurement of the growth of protective oxygen layers in LBE systems.

***For more information on Transmutation contact:
Mike Cappiello (505) 665-6408***

University of Nevada LV

UNLV Transmutation Research Program (TRP)

Administration

- Contractors met with the UNLV TRP Office and the UNLV Construction and Planning Office to inspect the ISTC Target Complex-1 loop and site and discuss the project requirements. The bidding process ended at the end of April. No schedule has yet been provided, but we anticipate completion within summer term.
- UNLV TRP Office received \$2.2 million in FY03 funds and awarded faculty-supervised graduate research tasks 1-4 their third and final year of funding. Tasks 13 and 14 received their second year of funding. And Tasks 5-12 received their summer 2003 funding. Also, infrastructure commitments through summer 2003 were obligated.
- 27 students and 4 professors who served as judges attended the American Nuclear Society Student Conference in Berkeley, CA, April 2-5, 2003. The following 17 papers were presented at the conference by UNLV students:
 - *Taide Tan*, Randy Clarksean, Yitung Chen, Hsuan-Tsung Hseih, Darrell Pepper, “Numerically Simulating the Solidification Process of a Melt Casing Metallic Fuel Pin Mold Using FIDAP” (Task 1).
 - *Sathish Subramanian*, Mohamed Trabia, William Culbreth, and Robert Schill Jr., “Modeling Optimization and Flow Visualization of Chemical Etching Process in Niobium Cavities” (Task 2).
 - Daniel Koury, *Brian Hosterman*, John W. Farley, Dale L. Perry, Denise Parsons, Julia Manzerova, Allen L. Johnson, “Surface Studies of Corrosion of Stainless Steel by Lead-Bismuth Eutectic” (Task 3).
 - *Ramprashad Prabhakaran*, “Stress Corrosion Cracking of Type 422 Stainless Steel” (Task 4).
 - *Subhas Pothana, Heidi Aquino*, “Environment-Induced Degradation of Cladding Materials” (Task 4).
 - *Sudheer Sama*, “Effects of Environmental Variables and Stress Concentration on Target Materials” (Task 4).
 - *Mohammad K. Hossain*, “Stress Corrosion Cracking in Target Materials” (Task 4), received Outstanding Paper Award.
 - *Xialong Wu*, Ramkumar Sivaraman, Yingtao Jiang, Woosoon Yim, Bingmei Fu, “Calibration of YSZ Sensors for the Measurement of Oxygen Concentration in Liquid Pb-Bi Eutectic” (Task 5).
 - *Kanthi Kiran Dasika*, Chao Wu, Samir Moujaes, Yitung Chen, “Modeling of Corrosion and Precipitation in the LBE Flow Loop and Study of Geometric Effects on Local Corrosion Rates” (Task 5).
 - *John P. Shanahan*, Mark J. Rudin, Phillip W. Patton, “An Interdatabase Comparison of Nuclear Decay Data Utilized in the Calculation of Dose Coefficients for Radionuclides Produced in a Spallation Neutron Source” (Task 7).
 - *Haritha A. Royyuru*, Lijian Sun, Yitung Chen, Hsuan-Tsung Hseih, Randy Clarksean, Darrell Pepper, “Development of an Optimization Systems Engineering Model for Spent Fuel Extraction Process” (Task 8).
 - *Richard A. Silva*, “3D Simulation of Manufacturing Processes for Transmuter Fuel Fabrication” (Task 9).
 - *Martin Lewis*, Mark Jones, Dr. Ajit K. Roy, Dr. Brendan O’Toole, “High-Temperature Deformation of Alloy EP-823 for Transmutation Applications” (Task 10), received Best Paper Award.
 - *Elizabeth Bakker*, “Critical and Thermal Investigation of Curium and Other Minor

Actinides for Safe Storage and Disposal” (Task 11).

- *Daniel Lowe*, “Monte Carlo Verification and Modeling of Lead-Bismuth Spallation Targets” (Task 12), received Outstanding Paper Award.
- *Anand Venkatesh*, “Residual Stress Measurement in EP 823 Using Non-Destructive Evaluation Techniques” (Task 14).
- *Vikram Marthandam*, “Residual Stress Measurements in Type 304 Stainless Steel Using Non-Destructive Techniques” (Task 14).
- **[Issues]** UNLV needs DOE to provide the remaining \$1.66 million in FY03 funding in a timely enough fashion to allow fall term accounts (Tasks 5-12 and Tasks 15 and 16) and program management, operation, and infrastructure accounts to be set up by August, 2003. Giving at least 10 days to set up accounts means that the award documentation should arrive at UNLV no later than July 18, 2003. A delay in receiving the funding award will severely compromise most activities at UNLV.

UNLV TRP Student Research

UNLV TRP Fuels

- The impact of mold preheat temperature and fuel pin diameter on the ability of copper and stainless steel mold to solidify all the molten material for 0.5 m fuel pin have been evaluated. (Task 1)
- The solidification processes of constant inlet velocity and constant pressure have been studied by using different molds preheated temperature, and different inlet pressure. (Task 1)
- The numerical model for the upper part of the casting furnace that includes the crucible and coils has been set up. The governing equations for the induction heating modeling have also been studied and developed. (Task 1)

UNLV TRP Separations

- The interface has been changed to implement the Object Oriented Programming (OOP) approach. With this approach our interface will be able to do all operations as done in AMUSE. (Task 8)
- Based on the following constraints we have developed three user controls to define the flow sheet: (Task 8)
 - All the sections should have a section name and number of stages.
 - First section should have both aqueous and organic streams.
 - Aqueous feed is mandatory to all sections.
 - Stage Sampling and Stage Specific Input can be given to any section.
 - Last section should have organic stream.
 - First section should have aqueous effluent as output
- Research initiated to develop and evaluate criteria for the use of commercial dry storage casks for strontium and cesium storage. (Task 11)
- Worked with Dr. Jim Laidler (Argonne National Laboratory) to develop research scope for FY03 proposal and to discuss future research. (Task 11)
- The new column for the IC iodide separation was received and tested. The interference problem is solved. (Task 15)
- We have conducted a number of experiments with alkali lignin and sphagnum moss to study iodide binding. The iodinated materials have been examined by pyrolysis. We have discovered that pyrolysis releases the bound iodide as methyl iodide. (Task 15)
- We have studied the alkali stability of several model organic iodides, to see if base promoted hydrolysis will be useful in concentrating iodine from NOM. (Task 15)
- We are close to finishing the assembly of the apparatus for simulating nuclear fuel dissolution.

Several additional glass items were ordered and we are awaiting delivery. (Task 15)

- We are close to finishing the assembly of the apparatus for simulating nuclear fuel dissolution. Several additional glass items were ordered and we are awaiting delivery. (Task 15)
- Baseline XPS and FT-IR spectra have been obtained for hydroxyapatite and fluorapatite. (Task 16)
- SEM images of natural fluorapatite crystals have been obtained, indicating the presence of natural inclusions containing transition metals (e.g., Ni), possibly providing useful information for comparison to man-made wastes with the same or similar species. (Task 16)
- **[Issues]** Due to difficulties implementing the UNLV-KRI contract, Task 15 still has not received any fullerene-containing carbon compounds for testing.

UNLV TRP Transmutation Sciences

- Calculation regarding the spatial resolution needed for SEE experiments have been performed. This will determine the type of position sensor technology needed for experimentation. (Task 2)
- Some initial flow visualization studies have begun. Gravitational forces appear to be more significant than flow forces causing the dye to diffuse into the mainstream too fast. (Task 2)
- Collaboration with x-ray microscopy group at Lawrence Livermore National Laboratory initiated. (Task 3)
- Stress corrosion cracking (SCC) tests using constant-load and slow-strain-rate (SSR) techniques are ongoing in aqueous solutions at elevated temperatures. (Task 4)
- SCC tests under controlled cathodic potentials (with respect to the corrosion potential) are

ongoing to evaluate the effect of hydrogen charging on cracking. (Task 4)

- Localized corrosion (pitting and crevice) behavior of all three alloys is being evaluated by cyclic potentiodynamic polarization (CPP) method. (Task 4)
- Metallographic evaluations by optical microscopy are ongoing. (Task 4)
- Fractographic evaluations by scanning electron microscopy are in progress. (Task 4)
- Self-loaded U-bend and C-ring specimens of Alloys HT-9 and EP-823 are ready to be tested for SCC evaluation. (Task 4)
- One technical paper based on the recent experimental data was presented at the 203rd meeting of the Electrochemical Society in Paris, France. (Task 4)
- Nuclear Transport Code models (MCNP 4B, MCNPX) were verified at UNLV and also with independent models completed by Dr. Richard Craig (at PNNL). (Task 6)
- ³He Neutron Multiplicity detector prototype (64 element) is completed and will be shipped to UNLV in May and is scheduled to arrive at HRC in early June '03. (Task 6)
- Neutron Multiplicity detector prototype (⁶Li glass fiber detector) is ~70% complete for all hardware and electronic card production. (Task 6)
- Production of detector material (⁶Li glass fiber) for the prototype sensor was begun and is nearing completion. Detector housing and light-tight enclosure in fabrication. (Task 6)
- Testing of the ⁶Li glass fiber detector system prototype scheduled at the Crocker Nuclear Laboratory, University of California, Davis for late May – mid-June 2003. (Task 6)

University of Nevada LV

- Completed the dose coefficients calculations for the QA radionuclides & evaluated 3 additional QA radionuclides. (Task 7)
- Implemented the new EDISTR computer code. (Task 7)
- Reclassified radionuclides into categories that can produce DC's. (Task 7)
- High-temperature tensile testing using specimen grips made of maraging steel in the presence of an inert atmosphere has been initiated. Temperature profiles for testing up to 600°C have been developed. (Task 10)
- The ambient temperature tensile • Parallelization of MCNPX for a Parallel Virtual Machine (PVM) complete. Working on Message Passing Interface (MPI) bugs and compiling problems. (Task 12)
- Writing a program to convert CAD files, more specifically IGES types, into a textual input deck to run in Monte Carlo programs. (Task 12)
- Analysis of linearization characteristics on Beowulf cluster complete. Now working on characteristics of the Supercomputing Center and the linearization of criticality studies. (Task 12)
- Most of the machining work for Task 13's apparatus has been completed. (Task 13)
- Testing of the LabView module for our apparatus was performed. (Task 13)
- Performed electrical test on the DC motor for our apparatus. (Task 13)
- Simulation continued with FEMLAB for the 3-D case in our design. Failed due to the lack of memory. (Task 13)
- Cold-worked, bent and welded specimens of heat-treated Alloy EP-823 and Type 304L stainless steel are being evaluated for residual stress measurements. (Task 14)
- All three types of specimens are being evaluated for residual stress measurements by positron annihilation spectroscopy at the Idaho State University (ISU). (Task 14)
- Residual stress measurements in bent and welded specimens have been completed at the Lambda Research Laboratory (LRL) using X-ray and Ring-Core methods. (Task 14)
- Metallographic evaluations of pre- and post-test samples have been initiated. (Task 14) Neutron diffraction method will be used on welded and bent specimens to measure the residual stresses. This work will be performed at LANL. (Task 14)
- **[Issues]** Letters of Invitation issued and visas begun for Russian colleagues to install and calibrate the ^3He -based Neutron Multiplicity detector system at the Harry Reid Center, UNLV, in early summer 2003. (Task 6)

***For more information on Transmutation contact:
Tony Hechanova at 9702) 895-1457.***

University Research Alliance - Fellowship Program

University Programs

- FY01 Fellow Alan Bolind (University of Illinois at Urbana Champaign) has finished his course requirements and is working on his thesis. He has been working on lead-bismuth corrosion through a research grant from Los Alamos. Phase I of the project began in late October and, as a result of discussions at the ANS Winter Meeting, a redesign of the system was undertaken, and the contract was extended from January 31 to March 31. Phase II began last week and it extends until May 31, 2004. Now that Phase I of the research is done, the lead-bismuth experiment is basically designed. Although construction is underway, Alan had to wait for Phase II money to be awarded to finish purchasing the remaining items. Now that the Phase II contract has been signed, Alan can resume construction. Meanwhile, he has been doing further research into impedance spectroscopy in order to estimate better the results he will get. (The results of the modeling and the comparisons with aqueous electrochemical systems are available.)

Alan hopes to have the experiment complete and running by June so that he can get at least one data point to present at the ANS conference. If the experiment can be completed by the end of the summer, his thesis could be deposited for either the August or the October deadlines.

Alan will be taking the qualifying exam for Ph.D. candidacy in August. He will be funded as a research assistant throughout the next academic year as a part of Phase II of the LANL contract.

- FY02 AFCI fellow Lisa Cordova (University of New Mexico) has been working one day a week at Sandia National Laboratory where she says she is learning a lot about Monte Carlo codes (her master's research involves a Monte Carlo proton code.) She will continue to work at SNL this summer which will enable her to interface with a person familiar with the discrete angle

method and further develop modeling skills.

- FY02 Fellow Lee Van Duyn (Georgia Tech) has been trying to get a better grasp on how the finite element computer code ABAQUS works, and trying to write a python scripting file that can generate the geometries that he would like to be able to form so that he can effectively run parameter studies when the model is complete. He has initially been successful in creating a basic model through the graphical user interface and solving for simple things like stress and strain and temperatures. He still has a number of numerical and computational problems to resolve. Lee will be working Steve Hayes and Mitch Meyer at ANL West this summer.
- FY02 Fellow Jennifer Ladd (University of Tennessee at Knoxville) will be working at ORNL this summer in the Higher Education Research Experience (HERE) and will be working on her thesis research. She hopes to be finished modeling by the end of the summer and begin writing her thesis by September.
- FY02 Fellow Billy Rothstein (University of Illinois at Urbana Champaign) has finished making his samples (thin Ni/Ti films on a Silicon substrate).
- FY02 Fellow Frank Szakaly (Texas A&M University) is working with LANL to acquire the security clearance necessary to access their computer network. He has written and is testing some input files to see if they work.
- FY02 fellow Will Wieselquist (North Carolina State University) is working on understanding the code NESTLE in order to integrate it effectively into his sensitivity analysis tool. Will is talking with Dr. Todosow of Brookhaven National Laboratory as Brookhaven is beginning a sensitivity analysis this November. They are coordinating so as to not duplicate each other's work and to make Will's studies most helpful to

University Research Alliance - Fellowship Program

Brookhaven. Will has finished the course work needed for his master's degree and will be working on his thesis this summer.

- AFCI Fellows Thomas Carter, Will Wieselquist, Tom McKittrick (University of Massachusetts at Lowell), and Alan Bolind plan to attend the ANS Annual Meeting in June.
- AFCI Fellows Kamilah Turner (University of Michigan) and Michael Gregson (University of Texas) graduated this semester.
- University Research Alliance coordinated the "International Meeting on Accelerator Driven Transmutation System Technologies" at UNLV on April 29.
- University Research Alliance is coordinating a meeting related to the proposed University Consortium for Transmutation Research at the ANS meeting in June.

For more information on the University Research Alliance contact: Cathy Dixon at (806) 376-5533